The Long-Run Effects of Warfare and Destruction on Children: Evidence from World War II*

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Abstract

During World War II, over one-half million tons of bombs were dropped in area raids on German cities, destroying about one-fifth of the total housing stock nationwide. This paper provides causal evidence on the long-run consequences of large-scale war destruction on the educational attainment and health status of German children. I combine a unique dataset on city-level destruction in Germany caused by Allied Air Forces bombing during WWII with individual survey data from the German Socio-Economic Panel (GSOEP). My identification strategy exploits the plausibly exogenous city-by-cohort variation in the intensity of WWII destruction. My findings suggest significant, long-lasting detrimental effects on the human capital formation of Germans who were school-aged during WWII. First, these children had 0.3 fewer years of schooling on average in adulthood, with those in the most hard-hit cities completing 1.2 fewer years. Second, these children were about half inches (one centimeter) shorter and had lower self-reported health satisfaction in adulthood. These results survive using alternative samples and specifications, including controlling for migration and instrumenting for WWII destruction, where distance to London is the instrumental variable for city-level war destruction. Moreover, a control experiment using older cohorts who were not school-aged during WWII reveals no significant city-specific cohort trends in schooling. An important channel for the effect of destruction on educational attainment appears to be the destruction of schools and the absence of teachers.

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1 Introduction

War has devastating consequences for a country, including loss of lives, physical injuries, displacement of people, destruction of public infrastructure and physical capital, and reduction in economic growth. Evidence from macro-level studies suggests rapid catch-up growth such that within 20-25 years, physical capital and other macroeconomic outcomes return to the pre-war steady state (Miguel and Roland, 2005; Brakman et al., 2004; Davis and Weinstein, 2002; Ben-David and Papell, 1995). However, the effects of wars along human dimensions could be longer lasting and as serious as physical impacts. Among war survivors, children may be especially adversely affected by war given the age-specific aspect of many human capital investments. For example, wars can interrupt the education of children through destruction of schools, absence of teachers, or deterioration of economic means in the household. Also, wars can worsen health through famines, malnutrition, mental distress, and outbreaks of communicable diseases (Ghobarah, Huth and Russett, 2003).

This paper provides new causal evidence on the long-run consequences of large-scale war destruction on the educational attainment and health status of children. Specifically, I use city-by-cohort variation in destruction in Germany due to World War II to estimate the effects of warfare and destruction on the human capital of individuals who were school-aged during WWII. This should be of interest for several reasons. First, WWII was a major, transformative event in modern history and it is important to understand its effects. Moreover, it informs on the general question of how war impacts children. Armed conflicts seem to have gotten more common and more physically destructive in recent years, making it policy-relevant to understand the long-run effects of war on children; to the extent that war has long-run detrimental effects on children's educational and health outcomes, policymakers can devise policies and programs to stem these effects.

My analysis combines a unique data set on the extent of WWII destruction for each German Regional Policy Region (Raumordnungsregionen, hereafter, "ROR", "region" or "city")[1] with individual-level data from a nationally-representative survey, the German Socio-Economic Panel (GSOEP). WWII destruction in Germany was caused primarily by the extensive bombing campaigns of the Allied Air Forces (hereafter, "AAF"). The AAF dropped over one-half million tons of bombs in area raids on German cities. The area raids destroyed or heavily damaged 3,600,000 dwelling units, approximately 20 percent of the total housing stock nationwide and 45 percent of the housing stock in large cities (USSBS, 1945; Diefendorf, 1993).

On the one hand, some regions experienced greater destruction than others. I discuss the determinants of destruction in detail Section 3; the essential point is that the intensity of WWII destruction depended on fixed regional characteristics (e.g., larger cities or cities with more visible landmarks were more likely to be targets of air raids) and chance (due to the technology and weather, only part of the time the intended exact target was hit and the maximal damage caused). On the other hand, only individuals who were school-aged during WWII (hereafter, "the affected cohorts") would have had their schooling affected by WWII destruction; the schooling of cohorts born after WWII would not be affected by this destruction[2]. This leads me to use a difference-in-differences-type strategy where the "treatment" variable is an interaction between regional intensity of WWII destruction and dummy for being school-aged during WWII, and where I always control for region fixed effects and cohort fixed effects. *The identifying assumption is that had the WWII destruction not occurred, the difference in schooling and health outcomes between the affected cohorts and the cohorts born after WWII would have been the same across regions of varying intensity of destruction.*

This paper makes several contributions. First, there are very few micro-level papers that rigorously quantify the long-run effects of war on children's human capital (these are dis-

[1]The analysis is restricted to former West Germany. West Germany is comprised of 75 RORs. RORs are analogous to metropolitan statistical areas (MSAs) in the U.S., though, in contrast to MSAs, RORs encompass rural areas too. That is, all of Germany, regardless of urbanicity, belongs to an ROR.

[2]As explained in section 4, I will use individuals born between 1951-1960 as the control group. Individuals born 1939-1950 are dropped since their exposure to WWII destruction is not clear; though they would have started the school after WWII ended, of course reconstruction did not occur overnight.

cussed in the literature review in the next section), and this paper adds to this small but growing literature. To the best of my knowledge, none of these studies use as detailed data on war damage as this paper. I have collected rubble per capita and bombing intensity data from historical and military archives for each of Germany's 75 regions. In contrast, the other studies (Ichino and Winter-Ebmer, 2004; Akresh and de Walque, 2008; and Shemyakina, 2006) use a measure of exposure to war that has limited spatial variation (only across countries, or across a few regions within a country). Having measures of exposure to war at a lower level of aggregation enables me to match the treatment to each individual more accurately and form more plausible control groups[3]. Second, I am able to distinguish between the amount of bombs dropped and the amount of destruction. Below, I use the realized destruction from the bombs as my measure of intensity of war exposure. Previous studies, to the extent that they have any measure of intensity of war exposure, have focused on the amount of bombs dropped. Because many bombs miss their target, the amount of bombs dropped is a noisy measure of the war destruction experienced by individuals. Finally, I attempt to empirically disentangle the mechanisms behind the estimated effects.

To preview my results, I find that that WWII destruction had detrimental effects on education and health even 40 years after the war. First, children who were school-aged during WWII had 0.3 fewer years of schooling on average in adulthood, with those in the most hard-hit cities completing 1.2 fewer years. Second, these children were about half inch (one centimeter) shorter and had lower self-reported health satisfaction in adulthood. These results survive using alternative samples and specifications, including controlling for migration and instrumenting for WWII destruction where instrumental variable for war destruction is distance to London. Moreover, a control experiment using older cohorts who were not school-aged during WWII reveals no significant city-specific cohort trends in schooling. An important channel for the effect of destruction on educational attainment appears to be the

[3]It is worth noting that Miguel and Roland (2006) measure bombing intensity in Vietnam at the district level, which is even lower a level of aggregation than I use here. However, their analysis is not at the individual level (it is at the district level) and they do not examine children's education and health outcomes (their only human-capital-related variable is fraction of the population that is literate.)

destruction of schools and the absence of teachers.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 provides a brief background of AAF bombing in Germany. Section 4 discusses the identification strategy. Section 5 describes the region-level destruction data and individual-level survey data used in the analysis. Section 6 presents the main results, extensions and robustness checks. Section 7 concludes.

2 Literature Review

An extensive literature looks at association between military and civil conflicts and country's socioeconomic performance from a macro perspective. One set of studies has focused on the impact of United States bombing on post-war macroeconomic outcomes at the city or regional level. Studies that examine the long-run effects of U.S. bombing during WWII-including in Japan (Davis and Weinstein, 2002) and in Germany (Brakman, Garretsen and Schramm, 2004) -find no evidence for the persistent impacts of the bombing on local population or economic performance. Using the extensive U.S. bombing campaigns in Vietnam during the Vietnam War as a quasi experiment, Miguel and Roland (2005) revisit the same question. They provide similar evidence suggesting that U.S. bombing did not have any long lasting impacts neither on physical infrastructure and local population, nor on literacy and poverty levels, 25 years after the Vietnam War. Thus, this strand of the literature mainly finds that war impacts are limited to the temporary destruction of physical capital, in line with the predictions of the neoclassical economic growth model which suggests rapid recovery to pre-war equilibrium levels.

Due to data constraints however, only small handful of studies have attempted to provide micro-level evidence on the cost of armed conflicts on civilian's outcomes, in particular that of children[4]. Using two cross-sectional household surveys collected before and after the

[4]However, an extensive prior literature has focused on the impact of military service on the human capital accumulation and later labor market outcomes of combatants. A number of studies have established that veterans experienced substantial deterioration in their earnings and health status after military service in

genocide in Rwanda, Akresh and de Walque (2008) find that school-age children exposed to the genocide in 1994 attain 0.5 fewer years of schooling and are less likely to complete third or fourth grade. Shemyakina (2006) examines the effects of civil conflict in Tajikistan and finds that school-age girls residing in conflict areas are less likely to complete secondary school education; however, the civil conflict had little, or no, effect on educational attainment of boys. Based on cross-cohort and cross-country comparison, Ichino and Winter-Ebmer (2004) investigate the long-run cost of World War II in Austria and Germany. They show that Austrian and German individuals who were 10 years old during or immediately after WWII acquire less education compared to other cohorts as well as to individuals of the same cohort born in non-war countries (namely, Switzerland and Sweden). They also demonstrate that the same cohort had significantly lower earnings 40 years after the war.

This study also closely relates to literature looking at association between conflicts and children's health status. Mainly focusing on African cases, the existing literature finds that malnutrition caused by civil conflicts in Africa hinders the physical development of children. These studies also show that poor health in childhood is associated with lower educational attainment and labor market earnings in adulthood. Alderman, Hoddinott and Kinsey (2004) find in Zimbabwe that exposure to civil war and drought shocks in early childhood are associated with lower height and education in adolescence. Akresh, Verwimp and Bundervoet (2007) find in Rwanda that such exposure is associated with lower height later in childhood. Exploiting the exogenous variation in the timing of war across provinces and across cohorts, Bundervoet, Verwimp and Akresh (2007) show that in Burundi, children who experienced the war have on average 0.515 standard deviations lower height-for-age z-scores relative to the other children.

To summarize, there have been few papers on the effects of war on children's educational

the U.S and Europe (Angrist, 1990, 1998; Angrist and Krueger, 1994; Imbens and van der Klaauw, 1995). Turning to African setting, Blattman and Annan (2007) provide new evidence on the impact of forced recruitment on veteran's human capital and labor market outcomes in Uganda. They show that youth who are forcefully recruited to rebellion forces attain less schooling and acquire fewer skills that may be required in the labor market later on. However, veterans are likely to be impacted by the war in different dimensions than the rest of the population who are not involved in the war; therefore prior studies on veterans provide limited information on the impact of wars on the civilian population.

and health outcomes. This paper adds new evidence to this small and growing literature. First, I use a source of variation to armed conflict that others have not used before-the variation in physical destruction caused by bombing during WWII across regions within Germany. Second, I am able to measure exposure to armed conflict at a lower level of aggregation than the other micro-level studies have done. Additionally, I look at longer-run outcomes than some of these other papers; the conflicts in Africa and former Soviet Union are more recent, so very long-run outcomes are yet to be realized.

3 Background on Allied Bombing of German Cities during WWII

During World War II, German cities experienced the widespread bombardment of the Allied Air Forces[5]. Bomber Command's area offensive represented "true air warfare" and bombing campaign was the only offensive action in Germany between June 1940 and June 1944 (Werrell, 1986). As a result of AAF's aerial attacks, 20 percent of the total housing stock nationwide and approximately 45 percent of the housing stock in the large cities were destroyed or heavily damaged. In Wurzburg, for instance, 89% of built-up residential area was destroyed; the figure in Remscheid and Bochum was 83%, in Hamburg and Wuppertal 75% (Diefendorf, 1993). Though most of the destroyed buildings were apartment houses, in every bombed city, schools, hospitals and other kinds of public buildings were also destroyed[6].

Starting from 1942, an overwhelming majority of the attacks consisted of "area bombing"[7]

[5]Information presented in this section is mainly gathered from the following historical sources: (i) the United States Strategic Bombing Survey (USSBS) (1945); (ii) Diefendorf (1993) "In the Wake of War: The Reconstruction of German Cities after World War II; and (iii) Grayling (2006) "Among the Dead Cities: Was the Allied Bombing of Civilians in WWII a Necessity or a Crime?" Regarding the first source, experts including John Kenneth Galbraith, Paul Baran and Nicolas Kaldor had conducted this extensive survey to examine the effectiveness of U.S. in WWII.

[6]Public buildings such as recreational and health facilities that remained in good condition after the air raids were confiscated for their own use by the AAF.

[7]Area raids were designed to spread destruction over a large area rather than to knock out any specific plant or installation. They were primarily intended to destroy the morale, particularly that of the industrial workers (USSBS, 1945).

at night rather than "precision bombing". Appendix Table 1 illustrates the shift toward area bombing. Sir Arthur Harris, the Commander Chief of RAF, regarded area bombing as the most promising method of aerial attack. Harris and his staff had a low opinion of economic intelligence and were skeptical of "target systems." Instead of trying to blow up each building with high explosive, which was an impossibly large task, the aim was to start a fire in the center of the each town, which-it was hoped-would consume the whole town. At the same time, they had a strong faith in the morale effects of bombing and thought that Germany's will to fight could be destroyed by the destruction of German cities (USSBS, 1945).

During area aerial attacks, AAF went on to bomb almost every major and minor German city, though the amount of bombs dropped and consequent destruction varied substantially across cities (see Figure 1, for share of dwellings destroyed in German cities by 1945). In Figure 1, the size of the circle shows the city size in 1939, where the biggest circle refers to cities with more than 500,000 inhabitants, middle-size circle cities with between 100,000 and 500,000 inhabitants and smallest circle cities with less than 100,000 inhabitants. The shaded area in these circles is the share of the dwellings destroyed in the city by the end of WWII. The targeted cities were not necessarily selected because they were particularly important for the war effort, but also for their visibility from the air, depending for example on weather conditions or visibility of outstanding landmarks such as cathedrals (Friedrich, 2002). In addition, Sir Harris positively insisted on bombing those cities which remained unbombed; and so his aircraft destroyed cities like Wurzburg and Hildesheim, noted more for their historical beauty than their military importance (Grayling, 2006)[8].

The degree of damage and the amount of resulting rubble depended upon number of factors including the distance of town from England, and technological developments at the time. In general, cities in the northern and western parts of Germany-those most easily

[8]An additional consideration on the selection of the targets is related to potential variation in regions' support for NSDAP (Nazi Party). For instance, regions known to be the strong supporters of the Nazi Party and Adolf Hitler might be more likely to be bombed by AAF. However the 1935 Statistical Year Book documents that the Nazi Party dominated the 1933 Election (last election before WWII) by getting 92.1% of all votes nationwide. In all regions in the sample, more than 90 percent of the votes went to the Nazi Party. Thus, there was really no meaningful variation in support for the Nazi Party across regions.

reached from the bases in England-suffered the most destruction. As a consequence, Berlin has not been hit as hard until the end of 1943 because of its great distance from the bomber airfields of Eastern England-it was nearly twice as far away as the cities in Ruhr Area (Diefendorf, 1993; Grayling, 2006). Along these lines, improvements in aircraft technology and operational techniques early in 1944 as well as improved quality and increased weight of bombs rendered continuous attacks deep in the heart of Germany possible. As a result, Allied airman dropped 72 percent of the bombs that fell on Germany after July 1, 1944 and only 14 percent of all bombs were aimed at specific targets (USSBS, 1945).

All in all, almost every city in Germany got exposed to the AAF air raids. Still, the amount of bombs dropped and the degree of destruction varied substantially across cities, as Figure 1 shows. The foregoing discussion of the historical accounts of the attacks on German soil suggest that the degree of destruction depended on fixed regional characteristics (e.g., larger cities and cities with more visible landmarks were more likely to be targets of air raids) and chance (due to the technology and weather, only part of the time the intended exact target was hit and the maximal damage caused). In my main analysis, I will take the cross-regional variation in intensity of WWII destruction as exogenous once I control for regional fixed effects. In supplemental analysis, I will treat this variation as endogenous and instrument for it using distance to London when estimating the effect of destruction on children's educational and health outcomes.

4 Identification Strategy

In this section, I describe my strategy for identifying the causal effect of WWII destruction on the German children's education and health. This strategy exploits the plausibly exogenous city-cohort variation in the destruction intensity. This is a difference-in-differences-type strategy where the "treatment" variable is an interaction between city-level intensity of WWII destruction and dummy for being school-aged during WWII. In particular, the proposed estimate of the average treatment effect is given by β in the following baseline region and birth cohort fixed effects equation:

$$Y_{irt} = \alpha + \beta(Intensity_r * WWII_{it}) + \delta_r + \gamma_t + \mathbf{X}'_{irt}\pi + \epsilon_{irt}, \tag{1}$$

where Y_{irt} is the outcome of interest for individual i in region r born in year t. $Intensity_r$ is the measure of destruction in region r. $WWII_{it}$ is a dummy variable that takes a value of 1 if individual i was born between 1924 and 1939 and zero otherwise. Individuals born between 1924 and 1939 were still at school-age education during WWII and their schooling has the potential to be affected by WWII destruction[9]. The schooling of individuals born after WWII would not have been impacted by this destruction; hence these later birth cohorts are in the control group[10]. δ_r is city-specific fixed effects, controlling for the fact that cities may be systematically different from each other. γ_t is the birth cohort-specific fixed effect, controlling for the likely secular changes across cohorts. Since I will be using a single cross section, this γ_t accounts for not only cohort but also age effects. $\mathbf{X}_{irt}$ is a vector of individual characteristics including gender and rural dummies as well as family background characteristics (e.g., parental education). ϵ_{irt} is a random, idiosyncratic error term.

In order to interpret β as the effect of war destruction, we must assume that had the WWII destruction not occurred, the difference in schooling and health outcomes between the affected cohorts and the cohorts born after WWII would have been the same across regions of varying intensity of destruction. I assess the plausibility of this assumption below by performing a falsification test/control experiment where I repeat the analysis using only cohorts who were already beyond school age.

[9] When height is the outcome of interest, the affected cohorts are defined differently. Previous research has shown that adult height is largely determined by age 2 or 3 and is significantly influenced by the diet and health conditions in the early childhood years (Brainerd, 2008). Guided by this research, when I look at height, the treatment group is restricted to individuals who were born between 1937 and 1945. Therefore, for height regressions, dummy variable $WWII_{it}$ takes a value of 1 if individual i was born between 1937 and 1945, and zero otherwise.

[10] As I explain below, I will use individuals born 1951-1960 as the control cohorts. Individuals born 1939-1950 are dropped since their exposure to WWII destruction is not clear; though they would have started school after WWII ended, of course reconstruction did not occur overnight.

5 Data and Descriptive Statistics

The measure of WWII destruction intensity that I use for my main analysis is from Kaestner (1949), who reports the results of a survey undertaken by the German Association of Cities ("Deutscher Staedtetag"). Kaestner (1949) provides regional-level information on rubble in m^3 per capita in 1945, which is what I use. This same source provides information on the percentage of the residential dwellings destroyed in 1946 in the territory of former West Germany.

To gain a better understanding of the source of the destruction by region, I also gathered data on bombing by region. Detailed regional-level military data have been assembled by Richard G. Davis, member of the historical staff at the U.S. Army's Center of Military History, from various archival sources[11]. This database contains detailed information on targeted country and city, exact date of the bombing, tons[12] and type of bombs dropped for virtually every aircraft sortie credited with attacking a target in Europe. The database mainly covers mining, supply missions, and special operations of the RAF Bomber Command and the US Air Force in Great Britain and Mediterranean.

In order to examine prewar conditions and assess the mechanisms through which WWII destruction might have affected children's education, I gathered data from various years of the German Statistical Yearbook. First, I assembled region-year data on the number of schools and number of teachers; of particular interest is the change in the number of schools and teachers immediately before and after the war because this would have been the change in school inputs available to the affected cohorts. Second, I compiled data from 1939 German

[11]Original archives supplied all the bombing information gathered for this database. For coverage of RAF Bomber Command night raids (January 1942 through May 1945), the raw data relies on Bomber Command Night Raid Reports and the Air Ministry War Room monthly operations summaries. For The US Army Air Forces aerial operations, this study utilizes the Eighth Air Force monthly operations reports (January 1944 through April 1945), the Eighth Air Force target summary (25 May 1945) and, most importantly, on the individual mission folders (17 August 1942 through 25 April 1945). In addition, Fifteenth U.S. Air Force and heavy bomber units of the Ninth and Twelfth Air Forces daily operations and intelligence summaries are incorporated.

[12]Tonnage of bombs is given in short tons (2000lbs.). British tonnage has been converted from long tons to short tons (B*2.240/2.000:A) where A is a pound (which is approximately 0.453 kg.)

Statistical Yearbook on pre-war regional characteristics including aggregate and average per capita income in German Reichsmarks in 1938, total area in square kilometers in 1939, and population size in 1939.

The data on individual and household characteristics come from the German Socio-Economic Panel (GSOEP). The GSOEP is a household panel survey that is representative for the entire German population residing in private households[13]. It provides a wide range of information on individual characteristics as well as parental background and the childhood environment in which one grows up. The GSOEP also incorporates war-related questions including whether father got involved in war and parent's death during the war years. I restrict the empirical analysis to individuals that were born between 1924 and 1960. I dropped individuals born between 1939 and 1950 from the analysis since their exposure to the WWII destruction is not as clear[14].

I consider WWII destruction impacts at the Regional Policy Regions (RORs) level which are spatial units defined by the Federal Office for Building and Regional Planning (Bundesamt fuer Bauwesen und Raumordnung, BBR) to differentiate between areas in Germany based on their economic interlinkages. There are 75 different regional policy regions in Germany (see Figure 2 for detailed information on RORs). The GSOEP is the only German dataset that provides information on the location of German households at ROR level along with other individual and household level information[15]. The GSOEP reports household's ROR information starting from 1985; thus I conduct the empirical analysis with 1985 wave of

[13]In the GSOEP, interviewers do face-to-face interviews with all members of a given survey household aged 16 years and over. The reduction in the population size for all individual samples is mainly the result of person-level dropouts, refusals, moving abroad, etc. However, the sample size increases as new persons move into already existing households and as children reach the minimum respondent's age of 16. Also, a person is followed up even after moving out of the household.

[14]The empirical findings are qualitatively similar if I use the entire sample and different cutoffs. The results for entire sample, where these 1939-1950 cohorts are added to the control group, are presented in Appendix Table 2. Point estimates tend to be smaller; this is not surprising since the control group now includes some cohorts that may have received partial treatment, i.e., they were affected to some extent by the destruction since reconstruction did not occur overnight.

[15]It would have been appealing to use German Census data due to the much larger number of observations available compared to the GSOEP. Unfortunately it is not possible to identify the ROR in the census data, and in fact the least aggregate geographic identifier available in the census is the state. This would not provide adequate variation in intensity of WWII destruction.

GSOEP[16]. I also restrict my analysis to West Germany, for which I have the war destruction data.

The GSOEP provides information on regions where individuals are residing in 1985 onwards. It would be ideal to have information on where children were during WWII but this is not available. However, the GSOEP asks respondents whether they still live in the city or area where they grew up[17]. This question helps me identify whether individuals still reside in their childhood city or area. On the other hand, it is well documented that Germany has historically low levels of geographic mobility in comparison to the U.S. and U.K. and that mobility is particularly low during childhood and early adulthood (Rainer and Siedler, 2005; Hochstadt, 1999). For example, mobility rates were very low during the period 1950-1970 among native Germans in the former West Germany, with an annual migration rate between states of around 0.02, defined as the ratio of number of migrants to or from a state within one year by the population of that state (Hochstadt, 1999)[18]. However, at a time of heavily aerial bombing, the urban population may have fled into the countryside, seeking shelter, food, and protection [19]. Nevertheless, historical records document that by June 1947, the urban population had reached 80 percent of prewar levels, then nearly 90 percent in 1948 (Hochstadt, 1999).

To form the final data set used in the analysis, I recoded the raw data on war destruction using German regional boundaries employed by GSOEP in 1985 and then merged it by ROR with the individual-level data from the GSOEP[20]. Table 1 presents the descriptive statistics

[16]For height, however I utilize 2002 wave since GSOEP reports the individual height starting 2002.

[17]The GSOEP question based on which the movers are identified in this paper is "Do you still live in the city or area where you grew up until age 15?" with three possible responses "yes, still", "yes, again", and "no". I have coded individuals those answered this question as "yes, still" and "yes, again" as non-movers. The interpretation of size of city or area is left to the perception of the respondents; therefore it is likely that even movers are migrating within the regions rendering the effect of war unchanged.

[18]In addition, individuals living in West Berlin in 1985 are excluded from the analysis as a robustness to avoid potential problems from East-West migration and the results are consistent with baseline specification.

[19]The source claims that Koln's population dropped to 9 percent of its prewar level in April 1945, with 84000 people leaving the city in one month, and then 55000 returning in the next month. This seems unlikely, although possible at a time of heavy aerial bombing. In general, the monthly population data in the source are best considered as estimates made during a time of extraordinary confusion (Hochstadt, 1993).

[20]The data on rubble in m3 per capita and percentage of housing units destroyed in 1946 are available for almost all municipalities with more than 12,000 inhabitants in 1939. Additional war destruction measures-

for population-weighted city-level war destruction measures and variables measuring prewar conditions. Table 1 shows that the average West German lived in a city that had a great deal of destruction-10.26 rubble in m^3 per capita and 31% of total housing units destroyed. There was variation across cities in destruction intensity; people in cities with above-average destruction had over three times the rubble per capita as people in cities with below-average destruction. Table 1 makes clear that highly destroyed cities are different than less destroyed regions. For example, highly destroyed cities are larger in area and have higher average income per capita in 1938. This highlights the fallacy of relying only on cross-regional variation in destruction to identify the effects of destruction; it is likely incorrect to attribute all differences in children's education and health outcomes between highly destroyed and less destroyed regions to war destruction because there are other differences between these regions that are correlated with the outcomes too. The difference-in-differences strategy I propose uses within-region cross-cohort to identify the effects of destruction, and controls for fixed differences between regions[21].

Table 2 shows the descriptive statistics of the outcomes and the main individual-level control variables I will use in my estimation. My main outcome of interest is years of schooling completed[22]. I will also analyze health outcomes. I use three measures of health: height in adulthood, self-reported health satisfaction and mortality. These outcomes are measured four decades after WWII, and reflect the outcomes of WWII survivors who lived to 1985 or later.

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bombing, schools, and teachers-are only available for municipalities with more than 20,000 individuals in 1939. To obtain the regional means of these additional war devastation measures, I merge these municipalities using 1985 GSOEP regional borders.

[21] There is a concern that the observed differences in levels of city size and per capita income suggest possible differences in trends in educational and health outcomes. Below, I assess whether there are differential trends by doing a falsification test/control experiment using data on cohorts who would have completed their schooling before WWII.

[22] The GSOEP asks respondents about educational attainment, then in the data files maps these attainment categories into years of schooling. While most of my regression analysis is with the years-of-schooling measure, I will also present results using the attainment categories.

6 Estimation Results

6.1 Estimates of War Destruction on Children's Educational Attainment

Table 3 reports the results of estimating Equation 1 where the dependent variable is years of schooling. Each column is from a separate regression that controls for region and birth year fixed effects along with female and rural dummies. The difference-in-differences estimate, β, is reported in the first row. It is negative and significant at 95% level of confidence in almost every specification. Columns 1-3 display the difference-in-difference estimates for whole population. Column 1 has an estimated β of -0.028 which suggests that WWII destruction caused the school-aged children to attain on average 0.3 fewer years of schooling (this is the coefficient multiplied by the mean intensity of destruction). Columns 2-4 present the results for specifications incorporating family background characteristics, such as father's and mother's education which are likely to serve as a proxy for parents' economic status. Each column 2-4 is from separate regression where the main treatment effect varies by parental human capital. Taken together with results summarized Columns (2)-(4) reveal that parental education mitigates the adverse effects of WWII destruction. Thus, children with less educated parents had a greater reduction in educational attainment. This effect may literally work through parental education (e.g., more educated parents value education more, and so ensure their children are educated too even if negative shocks occur) or through things correlated with parental education such as family income or wealth (e.g., rich families can afford to educate their children, and can hire private tutors or send children to boarding schools as necessary)[23].

A potential confounding factor for results summarized in Columns (1)-(3) of Table 3 is probability of the non-random migration across regions. For example, people residing in

[23]Additional specifications introduce war-related controls to the baseline specification such as whether father actively fought in the war and loss of parent during the war years to account for family's first hand experience with the consequences of the war. The results are robust to these additional controls and are available upon request.

heavily destroyed regions are likely to be displaced to less destroyed regions during heavy aerial attacks. Alternatively, highly destructed regions might attract a large number of post-war economic migrants that migrate to take part in reconstruction effort. Both types of migration might induce selection bias in the analysis of WWII destruction on children's education. To address whether individuals' migration decision is based on the destruction level of the regions, I estimate Equation 1 using the probability of moving as the dependent variable; results are reported in Table 4. Individuals are coded as movers if they report that they no longer reside in their childhood city or area. Treatment and control group for this specification is the same as for the Table 3 education analysis. The difference-in-difference estimates for probability of moving are close to zero and statistically insignificant in all specifications. This finding bolster our confidence that individuals did not choose their final destination according to the destruction level of the regions[24].

Table 5 provides further evidence on non-random migration concern. The analysis in Table 5 is restricted to individuals who still live in the city or area that they grew up (hereafter, "non-movers"). The difference-in-difference estimates for non-movers are very similar to the estimates for whole population. This finding further confirms that non-movers are not differentially impacted by the war shock and partially rules out the possibility of non-random migration.

Table 3 shows that war exposure decreases children's educational attainment by 0.3 years. It is also useful to estimate the effect of destruction on the distribution of education. For example, does the effect in Table 3 come from a reduction in middle school, secondary school or college completion? To address this question, I estimate the following baseline

[24]An additional concern related to mobility is refugees or people that fled from the former parts of Germany and Soviet zone/GDR. The first census held in the Federal Republic in 1950 registered 7.9 million refugees (7-9 percent of the 1939 population) (Schildt, 2006). This figure consists of Germans who were living in the eastern areas of the German Reich when war broke out and who are no longer counted as Germans, and 1.5 million who had immigrated from the Soviet zone/GDR. Most were initially settled in predominantly agricultural regions of Schleswig-Holstein (the expellees and refugees made up 33 percent of the population in September 1950), Lower Saxony (27 percent), Bavaria (21 percent), and Hesse (16 percent), where in some regions they actually constituted a majority of the population (Schildt, 2006). To address this potential concern, I estimate the baseline specification separately for regions with refugees above or below median using data provided by Redding and Sturm (2008). I found similar effects for both samples.

specification:

$$Y_{irtm} = \alpha + \beta_m(Intensity_r * WWII_{it}) + \delta_r + \gamma_t + \mathbf{X}'_{irt}\pi + \epsilon_{irtm}, \tag{2}$$

where the outcome of interest, Y_{irtm} is a dummy variable that indicates whether the individual i, born in region r, in year t, completed m years of schooling or more. β_m, for m=7 to 18, is the estimated effect of the WWII destruction for each levels of education. The estimation results for difference-in-difference estimates are plotted in Figure 3 (the 95% confidence interval is also shown). Figure 3 reveals at what level of education the adverse effect of war shock is present. The figure shows that war-exposure disrupts individual's educational formation in all levels of education-the point estimates are always negative. However, the adverse effects of war are more severe for young adults who were about to complete 12-14 years of schooling. The 12 years of schooling is associated with Gymnasium completion; gymnasium is the highest high school track in the German education system[25]. Therefore, Figure 3 suggests that children at high school age accounted for most of the detrimental impacts of WWII destruction. These older children were near school-leaving age, and had the WWII destruction not occurred they might have at least finished high school but instead they dropped out from school. By the time the war ended, they would have been young adults of the age when it is customary to work and therefore too old to return to school.

Results summarized in Table 3 rests on the assumption that in the absence of the WWII, the difference in educational attainment between affected group and the younger cohorts would have been similar across regions (this is known as the parallel trend assumption). That is, the coefficient for interaction between dummy for being born 1924-1939 and regional rubble per capita would be zero in the absence of WWII destruction. However, if there were differential cohort trends in educational attainment between more destroyed and less destroyed regions, then it would not be possible to interpret the difference-in-differences

[25] It is the academic track, required of those intending to attend college. The Gymnasium prepares students for the university entrance exam (Abitur) after grade 13 or gives them a chance to take a lower level qualification after grade 12, called Fachhochschulreife, which allows school leavers to attend a polytechnic

estimate as due to WWII destruction. To assess the validity of the identifying assumption, I perform the following falsification test/control experiment. I restrict the empirical analysis to older cohorts who would have completed their schooling at the outset of WWII. I code the oldest cohorts (i.e. born between 1904 and 1913) as the affected cohort and cohorts born between 1914 and 1923 as the control cohort though of course there is no true treatment here. If there are no differential trends, then the difference-in-differences estimates should be zero, which is indeed what I find (see Table 6). The results in Table 6 lend credence to the identification assumption in Equation 1 and support the interpretation of the difference-in-difference estimates as due to WWII destruction as opposed to some region-specific cohort trend.

An additional concern for the parallel trend assumption is that regional WWII destruction is endogenous, or that the post-war reconstruction effort is endogenous and correlated with WWII destruction. That is, it is possible that the post-war reconstruction effort was unevenly allocated towards more destroyed regions or those with higher industrial potential. In this case, the coefficient for the interaction between dummy for affected cohort and regional war destruction could yield a negative coefficient due to differences in reconstruction effort across regions rather than due to WWII destruction. To address this potential concern, I employ an instrumental-variables strategy. The instrumental variable that I use for a region's destruction is the region's distance to London obtained using Geographic Names Information System (GNIS). The choice of instrument is motivated by the historical records discussed in Section 3. As stated earlier, regions in the northern and western parts of Germany suffered the most from the AAF aerial bombing[26]. Therefore, the region's distance to London should be a good predictor of the regional war destruction. Figure 4 illustrates the association between region's distance to London and regional war destruction. Consistent with the historical sources, Figure 4 indeed shows that regions closer to London experienced more destruction as a result of AAF aerial raids. Panel B of Table 7 provides more formal

[26] I have chosen particularly London, since most of the RAF's airfields are located around London. For further information on RAF's airfields, visit www.mod.raf.uk. Moreover, American Air Forces used RAF's air base in Mildenhall during WWII for its operations in Europe, which is also very close to London.

evidence that the instrument, distance to London interacted with being born 1924-39, has a significant effect on the treatment variable, rubble per capita interacted with being born 1924-39[27]. As summarized in Panel B, the first-stage estimates are statistically significant at 1% significance level in all specifications reinforcing the hypothesis that regions further away from London exposed to considerably less destruction during WWII.

The results from estimating Equation 1 using two-stage least squares are given in Panel A of Table 7. Like the OLS estimates in Table 3, the 2SLS estimates show significant negative effects of WWII destruction. The 2SLS estimates are larger in magnitude compared to the OLS estimates. For example, Column 1 of Table 7 indicates that on average children completed 0.6 fewer years of schooling as a result of WWII devastation; this is twice the size of the OLS effects though of course the standard errors for the 2SLS estimates are large. Columns 2 and 3 incorporate parental human capital controls as before. As in Table 3, the negative treatment effect decreases when the parental education is taken into account. The remaining columns of Table 7 focus on non-movers. The point estimates are larger though again the confidence intervals are wide.

The difference-in-difference coefficient β in Equation 1 measures the average effect of warfare on children's education. However, it is of interest to explore whether the effect of war devastation varies by some measures of family background and individual characteristics. For instance, the adverse effects of war destruction might be alleviated through favorable family background. Alternatively, the war effect might vary by individual traits including gender and urban status. Indeed, Shemyakina (2006) shows that armed conflict in Tajikistan mainly deteriorates the educational attainment of adolescent girls but not boys. On the other hand, the negative consequences of war may be more evident for individuals residing in urban areas during their childhood[28] since urban areas were more likely to have been bombed by

[27]The first-stage equation is:

$$Intensity_r * WWII_{it} = \alpha + \beta(DistancetoLondon_r * WWII_{it}) + \delta_r + \gamma_t + \mathbf{X}'_{irt}\pi + \epsilon_{irt}, \quad (3)$$

where $DistancetoLondon_r$ measures the distance of region from London in miles as the crow flies, and δ_r and γ_t are region and birth year fixed effects.

[28]GSOEP asks respondent where they spent the major portion of your childhood up to age 15. I coded

AAF during WWII.

Column 2 of Table 8 considers whether the war effect is higher for individuals residing in urban areas through allowing main effect to vary by urban status. Additional motivation for this specification is to check whether the main results presented in Table 3 are driven by living in urban areas rather than the war effect. To rule out this potential concern, the coefficient for the interaction of treatment variable and urban dummy should be zero and statistically insignificant. Results presented in Column 2 suggest that the war impact is not heterogeneous by individual's urban status. This finding provides some suggestive evidence that the estimated treatment effects are not driven by the city size or living in urban areas.

In Column 3 of Table 8, I allow the effect of war destruction to vary by gender. Previous studies have found that under unfavorable circumstances and scarcity of resources, household resources are redistributed in favor of boys; most directly relevantly, Shemyakina (2006) found that civil conflict in Tajikistan reduced the secondary school completion of girls, not boys. The results reported in Column 3 of Table 8 do suggest that the adverse effect of warfare is indeed larger for females, though not statistically significantly different from the treatment effect for boys.

There are additional checks that might help us to understand the nature of the destruction and its impact on children's human capital formation. Equation 1 assumes that the association between regional war destruction and children's human capital is linear. However, one may expect the effect war destruction to be non-linear, e.g., when destruction surpasses a certain level then the detrimental effects become especially large, otherwise the effects are modest or negligible. To explore whether the negative effect of war devastation is more pronounced in most destroyed regions, I divide the destruction intensity measure into quartiles. The regions are ordered from heavily destroyed to least destroyed where top quartile refers to the regions with most destruction and bottom quartile is regions with the least destruction. The estimation results from this specification are displayed in Column 4 of Table 8, where the difference-in-difference estimates for individuals residing in most destroyed regions are

individuals as residing in urban area if they respond this question as in "city" or "town".

reported. Column 4 of Table 8 shows that the adverse effects of warfare are substantially larger in regions with the most destruction. Children in most hard-hit regions attain 1.23 fewer years schooling relative to the control group; this effect is twice as large as for the second and bottom quartiles. Further analysis reveals that the difference-in-difference estimate for the top quartile is statistically significantly different from the estimates for the other three quartiles[29]. Thus, it does appear that though warfare negatively affects the children's schooling throughout Germany, children in the most war-torn areas lost the most years of schooling.

To summarize the estimation results so far, I find that WWII destruction reduced the educational attainment of Germans who were school-aged during WWII. The reduction in education is borne disproportionately by people living in the most hard-hit regions, and whose parents were less educated. Analysis of the impact at each point in the education distribution suggests that the destruction caused children who might otherwise have completed the academic high school track to drop out, leading to a decrease in the probability of completing 12 years of schooling and attending some college. These impacts on educational attainment are both statistically and economic significant.

It is of interest to understand the mechanisms through which war destruction affected the educational attainment of children. I find that results are basically unchanged if I control for parent fighting in WWII or dying during WWII, which suggests that it is not direct family experience in WWII combat that is responsible for the effects on children's schooling[30]. A likely mechanism seems to be the destruction of schools and the disruption in schools left standing. Figures 5 and 6 present the change in number of schools and teachers over time by destruction intensity. From these figures, it appears that regions with more rubble per capita also had a greater decline in both the number of schools (because schools were destroyed too

[29]First, I test whether the difference-in-difference estimates are the same for the bottom three quartiles. The corresponding F-statistic is 0.48 suggesting that they are not statistically different. Second, I test whether the difference-in-difference estimates for the top quartile is different from the other three quartiles. The F-statistic for this test is 6.32 indicating that the difference-in-difference coefficient for top quartile is statistically different from the estimates for the other three quartiles at the 5% significance level.

[30]These results are available upon request from the author.

as part of the AAF bombing) and the number of teachers (some teachers had to perform military service, and a significant number were Jewish). A story in which children in more destroyed areas receive less schooling because the schools are defunct due to bombing or departure of teachers is consistent with these empirical observations. Of course it is not possible to provide definitive proof of this story, and undoubtedly additional mechanisms are at work too, but this seems to be a plausible and important mechanism for the effects of destruction on schooling.

6.2 Estimates of War Destruction on Health Outcomes

Now, I turn to estimating the impact of WWII destruction on individuals' health outcomes. The health outcomes I will measure are mortality, health satisfaction and height. The fetal origins hypothesis suggests that malnutrition and poor living conditions in-utero and early childhood may have effects on later life outcomes (Baker, 1992), including life expectancy (Van den Berg, Lindeboom and Portrait, 2006), health status and height (Banerjee, Duflo, Postel-Vinay and Watts, 2007), cognitive ability (Case and Paxson, 2006), and labor market earnings (Ravelli et al 1998, Case and Paxson, 2006; Qian and Meng, 2006). Recent research has also clearly established that individual's height is an important ingredient of professional and personal success. It is documented that unfavorable childhood environment not only deteriorates the individual's height in childhood but also reflected upon individual's height in adulthood and consequently their earnings and choice of occupation (Case and Paxson, 2006, 2008). Given these studies, it is of interest to explore whether war destruction affects the long-run health outcomes of individuals who were children during WWII. A mediator for these long-run health effects, especially height in adulthood, is childhood nutritional status. WWII created food shortages and changes in the composition of food eaten which could have had especially detrimental effects on young children.

Table 9 reports the difference-in-difference estimates for adult health outcomes. The treatment and control groups described above for the education analysis applies for these outcomes as well with the exception of height. Previous research has established that adult height is largely determined by age 2 or 3 and is significantly influenced by the diet and health conditions in the early childhood years (Brainerd, 2008). Thus, for height regressions, the treatment group is restricted to individuals who were born between 1937 and 1945, i.e. dummy variable $WWII_{it}$ takes a value of 1 if individual i was born between 1937 and 1945, and zero otherwise.

Panel A of Table 9 examines the effect of WWII destruction on individual's height (measured in inches). All regressions show a significant negative effect on height that is significant at the 5% significance level. In column 1 of Table 9, the difference-in difference estimate is -0.039 indicating that individuals experienced WWII are on average about half inch shorter in adulthood than the others. This is a sizable effect since average height grew by only 0.8 inches in the entire 19th century (Banerjee, Duflo, Postel-Vinay and Watts, 2007).

Panel B present the results for the mortality of WWII survivors. For this analysis, I take advantage of the panel structure of GSOEP. The mortality variable is a dummy variable that takes a value of 1 if individual has recorded death year sometime between 1985 (the beginning of my sample) and 2006, and zero otherwise. Columns (4)-(6) provide weak evidence that WWII destruction caused Germans who were school aged during WWII to die sooner. None of the effects are significant in Panel A.

Finally Panel C estimates the effect of war destruction on self-reported health satisfaction. Health satisfaction is often considered to have significant explanatory power in predicting future mortality and is therefore a useful measure of morbidity (Idler and Benysmini, 1997, Frijters, Haisken-DeNew and Schields, 2005). Health satisfaction in the GSOEP is measured on a scale from 0 to 10. Individuals are coded as satisfied with their current health if their response is 6 and above. The results in Panel C are generally negative and significant. Thus, war destruction does worsen long-run health status (which is undoubtedly a reason for the higher mortality shown in Columns Panel B).

To summarize the health results, I find that war destruction led to worse health in adulthood for Germans who were children during WWII-these children are shorter, report lower satisfaction with their health and are more likely to die. While there are many mechanisms through which exposure to war and destruction might impact health status (e.g., trauma, mental illness), given the sizable impact on height, it is likely that malnutrition is an important mechanism.

7 Conclusion

This paper presents causal evidence on the long-run socioeconomic consequences of world's most costly and widespread global military conflict, WWII, on German children. I combine individual-level data from the German Socio-Economic Panel (GSOEP) with unique datasets on regional WWII bombing intensity and destruction to study the long-run effects of WWII destruction on children's education and health. The identification strategy exploits plausibly exogenous city-by-cohort variation in the intensity of WWII destruction. I find that WWII destruction caused Germans who were school-aged during WWII to complete fewer years of schooling, be shorter in height, report lower satisfaction with their health and die sooner. The detrimental, long lasting effects of WWII destruction is borne disproportionately by people living in the most-hard hit regions, and whose parents were less educated. On the other hand, the destruction of schools and decline in number of teachers seems to be an important channel for the reduction in education. Malnutrition during WWII appears to be an important channel for the estimated impacts on health.

Taken together, these findings suggest that though severely hit regions rapidly return to their prewar patterns in terms of local population and macroeconomic outcomes, consequences of wars along human dimensions could be more substantial and persistent. Given that the detrimental effect of WWII is still present 40 years after WWII, these results underline the importance of policies targeting school-age children after the armed conflicts.

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Table 1. Descriptive Statistics for WWII Destruction

	All	Cities with above avg. destruction	Cities with below avg. Destruction	Difference s.e(difference)	
	(1)	(2)	(3)	(4)	
Rubble in m3 per Capita	10.264	18.486	5.593	12.893	***
	(7.532)	(4.770)	(3.923)	(1.064)	
Total bombs dropped in tons	14,414.560	21,381.550	9,505.998	11,875.552	***
	(18,235.960)	(24,066.690)	(10,418.810)	(4,080.946)	
Area in km2 in 1938	154.246	216.324	110.510	105.814	**
	(183.784)	(250.466)	(98.104)	(41.659)	
Population density in 1939	1,730.194	1,783.781	1,692.440	91.341	
	(801.210)	(889.216)	(741.314)	(190.294)	
Income per Capita in RM	455.827	498.194	419.979	78.215	**
in 1938	(109.439)	(82.670)	(117.728)	(29.853)	
Refugees as a fraction of pop.	0.219	0.203	0.230	-0.027	*
in 1961	(0.067)	(0.066)	(0.067)	(0.016)	
Distance to London in miles	425.444	398.730	444.266	-45.536	**
	(87.206)	(82.478)	(86.397)	(19.885)	
N Max.	75	31	44	75	

Notes: The sample consists of 75 Regional Policy Regions (Raumordnungsregionen, ROR) in the former territory of West Germany. The means for for destruction measures are weighted by population. Standard deviations are in paranthesis. *The U.S dollar worth 4.02 RM in 1938.

Table 2. Descriptive Statistics, GSOEP Data

	All	Cities with above avg. destruction	Cities with below avg. destruction
	(1)	(2)	(3)
Years of Schooling	11.288	11.396	11.179
	(2.316)	(2.391)	(2.234)
Height	170.078	170.302	169.864
	(8.787)	(8.712)	(8.859)
Health Satisfaction	0.696	0.680	0.711
	(0.460)	(0.467)	(0.453)
Mortality Rate	0.134	0.139	0.129
	(0.341)	(0.346)	(0.335)
Father's Education	9.383	9.428	9.338
	(1.055)	(1.106)	(1.000)
Mother's Education	9.186	9.210	9.163
	(0.690)	(0.720)	(0.657)
Age	42.913	42.921	42.904
	(12.374)	(12.440)	(12.311)
Female	0.506	0.500	0.512
	(0.500)	(0.500)	(0.500)
Rural	0.427	0.374	0.480
	(0.495)	(0.484)	(0.500)
N max.	3706	1863	1843

Notes: Data are from 1985 GSOEP. The sample consists of individuals born between 1924 and 1960. Individuals born between 1939 and 1950 are dropped from the analysis since their exposure to the WWII destruction is not as clear.

Table 3. The Effect of WWII Destruction on Children's Years of Schooling

	All			
	(1)	(2)	(3)	(4)
Rubble per Cap.X Born btw.1924-1939	-0.0277 **	-0.0217 **	-0.0245 **	-0.0222 **
	(0.0137)	(0.0111)	(0.0112)	(0.0110)
Rubble per Cap.X Born btw.1924-1939		0.0277		0.0114
X Father has High School and Above		(0.0175)		(0.0221)
Rubble per Cap.X Born btw.1924-1939			0.0345 *	0.0235
X Mother has High School and Above			(0.0204)	(0.0264)
R^2	0.1589	0.2954	0.2664	0.3188
N	3573	3103	3138	3056

Notes: Standard errors clustered by cities are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). The control group is individuals born between 1951 and 1960. Each column is from separate regression where main treatment effect varies by parental education in Columns (2)-(4). Each column controls for city and year of birth fixed effects. Columns (2)-(4) control for main effects of parental human capital. Other controls in each regression are gender and rural dummies.

Table 4. The Effect of WWII Destruction on Probability of Moving

	(1)	(2)	(3)	(4)
Rubble per Cap.X Born btw.1924-1939	0.0016	0.0036	0.0033	0.0031
	(0.0028)	(0.0029)	(0.0029)	(0.0028)
Rubble per Cap.X Born btw.1924-1939 X Father has High School and Above		-0.0030		-0.0019
		(0.0028)		(0.0028)
Rubble per Cap.X Born btw.1924-1939 X Mother has High School and Above			-0.0021	-0.0019
			(0.0034)	(0.0037)
R^2	0.1021	0.1272	0.1204	0.1295
N	3570	3103	3138	3056

Notes: Standard errors clustered by cities are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). The control group is individuals born between 1951 and 1960. Each column is from separate regression where main treatment effect varies by parental education in Columns (2)-(4). Each column controls for city and year of birth fixed effects. Columns (2)-(4) control for main effects of parental human capital. Other controls in each regression are gender and rural dummies. Individuals are coded as movers if they report that they no longer reside in their childhood city or area.

Table 5. The Effect of WWII Destruction on Children's Years of Schooling

	Non-Movers Only			
	(1)	(2)	(3)	(4)
Rubble per Cap.X Born btw.1924-1939	-0.0340 **	-0.0286 **	-0.0309 **	-0.0282 **
	(0.0149)	(0.0124)	(0.0124)	(0.0123)
Rubble per Cap.X Born btw.1924-1939		0.0105		0.0098
X Father has High School and Above		(0.0280)		(0.0315)
Rubble per Cap.X Born btw.1924-1939			-0.0050 *	-0.0083
X Mother has High School and Above			(0.0312)	(0.0364)
R^2	0.1860	0.2941	0.2683	0.3170
N	1964	1688	1708	1660

Notes: Standard errors clustered by cities are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). The control group is individuals born between 1951 and 1960. Each column is from separate regression where main treatment effect varies by parental education in Columns (2)-(4). Each column controls for city and year of birth fixed effects. Columns (2)-(4) control for main effects of parental human capital. Other controls in each regression are gender and rural dummies.

Table 6. The Effect of WWII Destruction on Children's Years of Schooling

Control Experiment

	(1)	(2)	(3)	(4)
Rubble per Cap.X Born btw.1904-1913	0.0063	0.0112	0.0064	0.0078
	(0.0158)	(0.0152)	(0.0138)	(0.0151)
Rubble per Cap.X Born btw.1904-1913 X Father has High School and Above		0.0054		0.0232
		(0.0261)		(0.0400)
Rubble per Cap.X Born btw.1904-1913 X Mother has High School and Above			-0.0209	-0.0225
			(0.0491)	(0.0626)
R^2	0.2371	0.3846	0.3381	0.3941
N	1315	1080	1084	1064

Notes: Standard errors clustered by cities are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). Sample consists of older cohorts who were born between 1904 and 1913 who would have completed their schooling at the outset of WWII. "Placebo" affected group is individuals born between 1904 and 1913 and "Placebo" control group is individuals born between 1914 and 1923. Each column is from separate regression where main treatment effect varies by parental education in Columns (2)-(4). Each column controls for city and year of birth fixed effects. Columns (2)-(4) control for main effects of parental human capital. Other controls in each regression are gender and rural dummies.

Table 7. The Effect of WWII Destruction on Children's Education

Instrumental Variable Strategy

	All	Non-Movers Only
	(1)	(2)
Panel A: Second-stage Equation		
Rubble per Cap.X Born btw.1924-1939	-0.0565 **	-0.0852 **
	(0.0279)	(0.0351)
Panel B: First-stage Equation		
Dependent Variable: Rubble per Capita X Born btw. 1924 and 1939		
Distance to London (in miles) X Born btw.1924-1939	-0.0331 ***	-0.0326 ***
	(0.0013)	(0.0018)
F-Statistic for first-stage	**153.86**	**77.05**
R^2	0.8381	0.8242
N	3573	1964

Notes :Standard errors adjusted for cities are shown in parentheses. Asterisks denote significance levels (*=.10,**=.05,***=.01). The identifying instrument for city-level war destruction is city's distance to London in miles. Each column controls for region and year of birth fixed effects. Other controls in each regression are gender and rural dummies. Non-movers are defined as individuals who still reside in the city or area where they grow up.

Table 8. The Heterogenity in the Effect of WWII Destruction on Children's Education

	Base Specification	Source of Heterogeneity: Urban Area	Source of Heterogeneity: Female	Top Quartile Destruction
	(1)	(2)	(3)	(4)
Rubble per Cap.X Born btw.1924-1939	-0.0277 **	-0.0275 **	-0.0271 **	-1.2333 ***
	(0.0137)	(0.0117)	(0.0132)	(0.3482)
Rubble per Cap.X Born btw.1924-1939 X Source of Heterogeneity		-0.0002	-0.0094	
		(0.0093)	(0.0088)	
R^2	0.1589	0.1589	0.1576	0.1483
N	3573	3573	3573	3573

Notes: Standard errors clustered by cities are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). The control group is individuals born between 1951 and 1960. Each column is from separate regression where main treatment effect varies by source of heterogeneity. "Top Quartile Destruction" is a dummy variable which takes a value of 1 for being in cities with most destruction. Each column controls for city and year of birth fixed effects. Other controls in each regression are gender and rural dummies.

Table 9. The Effect of WWII Destruction on Adult Health Outcomes

	(1)	(2)	(3)	(4)
Panel A: Height				
Rubble per Cap.X Born btw. 1937-1945	**-0.0382** **	**-0.0420** **	**-0.0383** **	**-0.0388** **
	(0.0176)	**(0.0198)**	**(0.0181)**	**(0.0193)**
Rubble per Cap.X Born btw.1937-1945 X Father has High School and Above		-0.0104		-0.0081
		(0.0220)		(0.0215)
Rubble per Cap.X Born btw.1937-1945 X Mother has High School and Above			-0.0003	0.0009
			(0.0319)	(0.0283)
R^2	0.5308	0.5392	0.5359	0.5379
N	1493	1389	1424	1216
Panel B: Mortality				
Rubble per Cap.X Born btw.1924-1939	**0.0012**	**0.0027**	**0.0018**	**0.0023**
	(0.0014)	**(0.0017)**	**(0.0017)**	**(0.0193)**
Rubble per Cap.X Born btw.1924-1939 X Father has High School and Above		-0.0040 *		-0.0035
		(0.0021)		(0.0033)
Rubble per Cap.X Born btw.1924-1939 X Mother has High School and Above			-0.0033 *	-0.0010
			(0.0017)	(0.0032)
R^2	0.1605	0.1658	0.1640	0.1658
N	3537	3060	3094	3009
Panel C: Self-Rated Health Satisfaction				
Rubble per Cap.X Born btw.1924-1939	**-0.0037** *	**-0.0058** **	**-0.0054** **	**-0.0054** **
	(0.0020)	**(0.0024)**	**(0.0024)**	**(0.0023)**
Rubble per Cap.X Born btw.1924-1939 X Father has High School and Above		0.0087 ***		0.0082 **
		(0.0029)		(0.0040)
Rubble per Cap.X Born btw.1924-1939 X Mother has High School and Above			0.0051 **	0.0004
			(0.0025)	(0.0036)
R^2	0.1180	0.1301	0.1283	0.1321
N	3595	3116	3147	3067

Notes :Standard errors clustered by cities are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). For all health outcomes, the control group is individuals born between 1951 and 1960. For height regressions, the treatment group is individuals born between 1937 and 1945. Mortality measure is a dummy variable that takes a value of 1 if individual has recorded death year from 1985 (second year of survey) until 2006 and zero otherwise. Health satisfaction is a subjective and scaled measure of health that ranges between 0 and 10. Individual is coded as satisfied with their current health if their response is 6 and above.Each column controls for city and year of birth fixed effects. Other controls in each regression are gender and rural dummies.

Table 10. The Heterogenity in the Effect of WWII Destruction on Health Outcomes

	Base Specification	Urban Area	Female	Top Quartile Destruction
		Source of Heterogeneity		
	(1)	(2)	(3)	(4)
Pane A: Height				
Rubble per Cap.X Born btw.1924-1939	-0.0382 **	-0.0479 **	-0.0457 **	-1.4402 ***
	(0.0176)	(0.0199)	(0.0178)	(0.5329)
Rubble per Cap.X Born btw.1924-1939 X Source of Heterogeneity		0.0129	0.0073	
		(0.0169)	(0.0167)	
R^2	0.5308	0.5423	0.5339	0.5310
N	1493	1493	1493	1493
Panel B: Mortality				
Rubble per Cap.X Born btw.1924-1939	0.0012	0.0010	0.0035 **	0.4733 ***
	(0.0014)	(0.0016)	(0.0015)	(0.0829)
Rubble per Cap.X Born btw.1924-1939 X Source of Heterogeneity		0.0004	-0.0046 ***	
		(0.0014)	(0.0012)	
R^2	0.1605	0.1605	0.1549	0.1610
N	3537	3537	3537	3537
Panel C: Self-Rated Health Satisfaction				
Rubble per Cap.X Born btw.1924-1939	-0.0037 *	-0.0047 **	-0.0025	-0.3687 ***
	(0.0020)	(0.0023)	(0.0023)	(0.1087)
Rubble per Cap.X Born btw.1924-1939 X Source of Heterogeneity		0.0038 *	0.0003	
		(0.0020)	(0.0019)	
R^2	0.1180	0.1116	0.1011	0.1105
N	3595	3595	3595	3520

Notes: Standard errors clustered by regions are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). The control group is individuals born between 1951 and 1960. Each column is from separate regression where main treatment effect varies by source of heterogeneity. "Top Quartile Destruction" is a dummy variable which takes a value of 1 for being in cities with most destruction. Each column controls for city and year of birth fixed effects. Other controls in each regression are gender and rural dummies.

Appendix Table 1. Summary of Allied Air Forces Area Raids

	Area Raids	Other Raids	Total	Area Raids
1940	1,453	12,094	13,547	11%
1941	14,475	22,631	37,106	39%
1942	39,044	11,412	50,456	77%
1943	131,668	74,520	206,188	64%
1944	324,965	876,569	1,201,534	27%
1945	96,428	384,721	481,149	20%
Total	608,033	1,281,947	1,989,980	31%

Source: United Strategic Bombing Survey, The Effects of Strategic Bombing on the German War Economy (October, 1945), pp.2-5, Tables 1-4.; Diefendorf (1993)

Appendix Table 2. The Effect of WWII Destruction on Children's Education

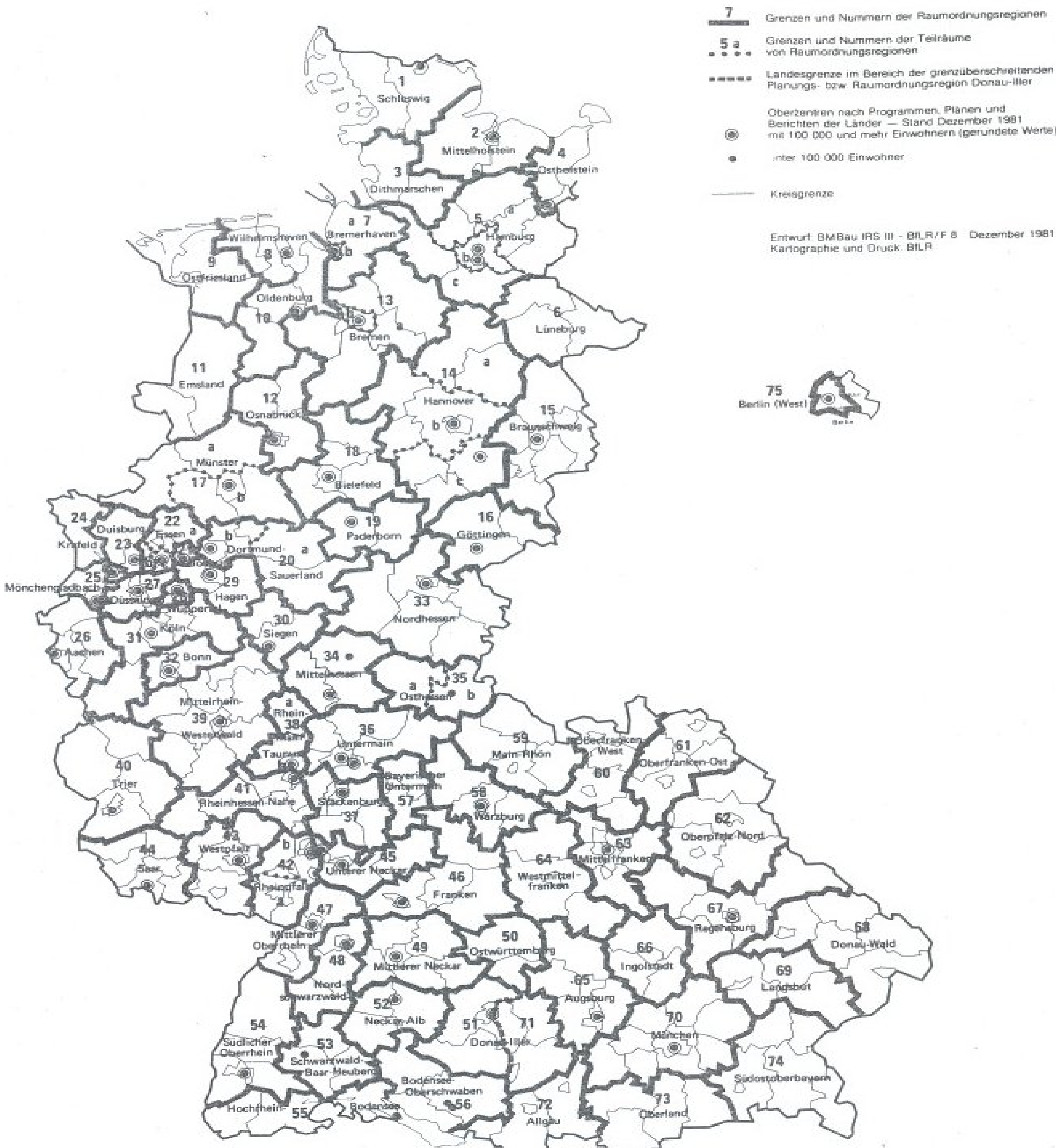
	All			
	(1)	(2)	(3)	(4)
Rubble per Cap.X Born btw.1924-1939	-0.0195 **	-0.0169 **	-0.0171 **	-0.0169 **
	(0.0093)	(0.0089)	(0.0089)	(0.0110)
Rubble per Cap.X Born btw.1924-1939		0.0279 *		0.0089
X Father has High School and Above		(0.0154)		(0.0191)
Rubble per Cap.X Born btw.1924-1939			0.0393 **	0.0278
X Mother has High School and Above			(0.0180)	(0.0226)
R^2	0.1428	0.2801	0.2430	0.2993
N	5047	4343	4415	4275

Notes: Standard errors clustered by cities are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01). The control group is individuals born between 1940 and 1960. Each column is from separate regression where main treatment effect varies by parental education in Columns (2)-(4). Each column controls for city and year of birth fixed effects. Columns (2)-(4) control for main effects of parental human capital. Other controls in each regression are gender and rural dummies.

Figure 1: Share of dwellings destroyed in German cities by 1945

Source: Knopp (2001). The size of the circle shows the city size in 1939, where the biggest circle refers to cities with more than 500,000 inhabitants; middle-size circle cities with between 100,000 and 500,000 inhabitants and smallest circle cities with less than 100,000 inhabitants. The shaded area in these circles is the share of the dwellings destroyed in the city by the end of WWII.

Figure 2: Map of Regional Policy Regions (*Raumordnungsregionen*, ROR) in West Germany



Source: Federal Office for Building and Regional Planning (*Bundesamt für Bauwesen und Raumordnung*, BBR)

Figure 3: Estimated Effect of Destruction on Full Distribution of Education

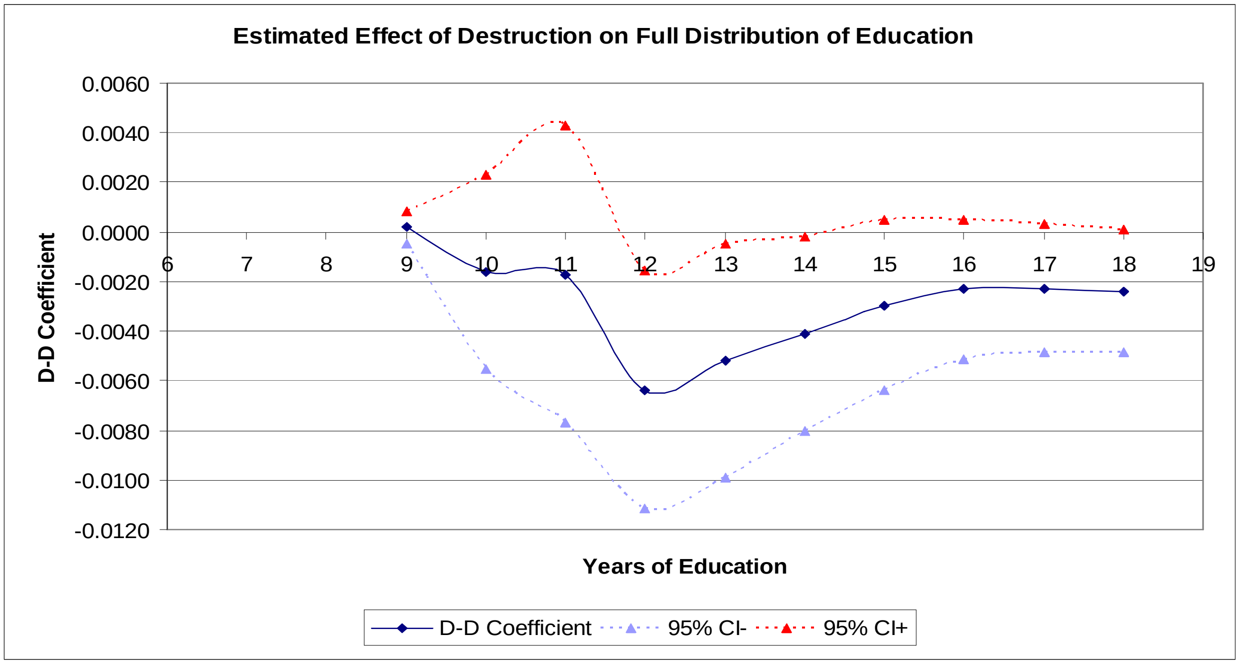


Figure 4: Distance to London and Regional WWII Destruction (First-Stage)

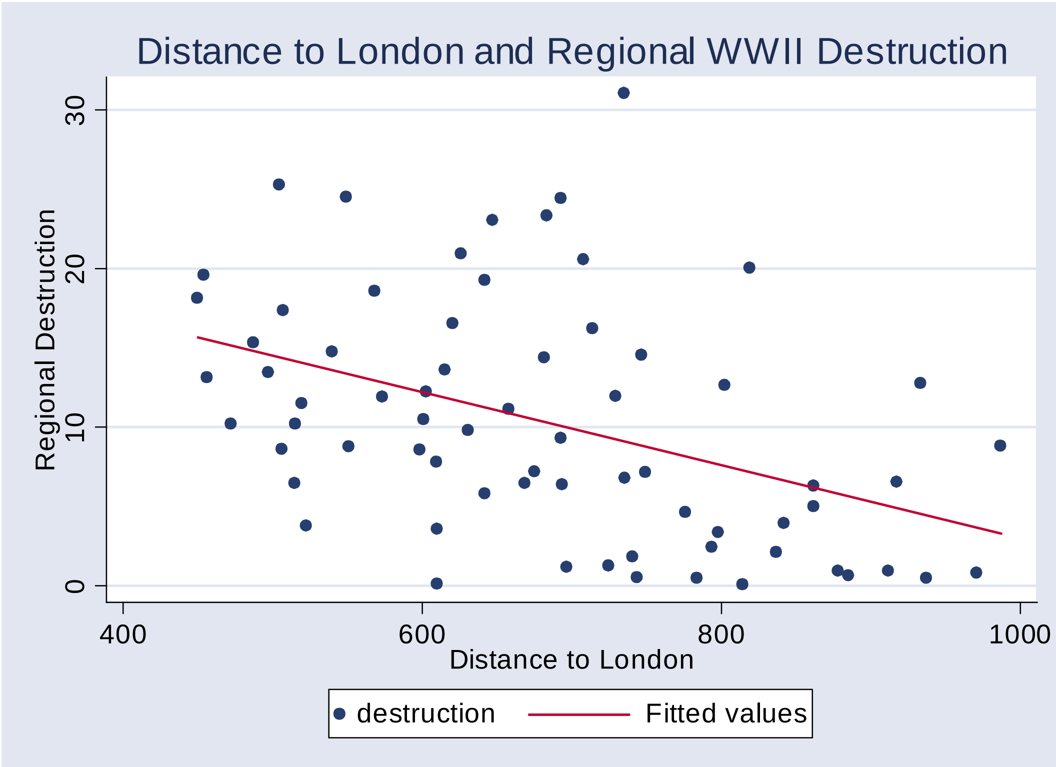


Figure 5: Number of Schools by Regional WWII Destruction

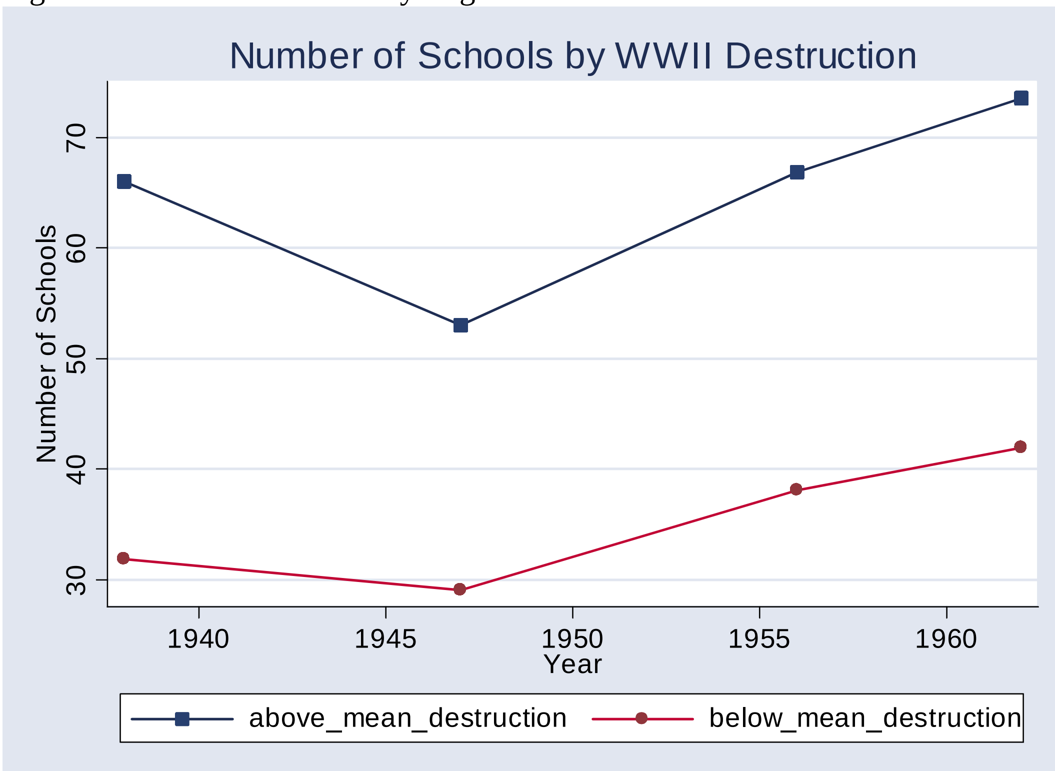


Figure 6: Number of Teachers by Regional WWII Destruction